

In all these cases of true secular stability, instability supervenes through tidal friction, and not, as in the case of Roche's problem, through the deformation of figure.

When Poincaré announced that there was a figure of equilibrium of a single mass of liquid shaped something like a pear, he also conjectured that the constriction between the stalk and the middle of the pear would become developed until it was a thin neck; and yet further that the neck might break and the two masses become detached. The present revision of Roche's work was undertaken in the hope that it would throw some light on the pear-shaped figure in the advanced stage of development.

As a preliminary to greater exactness, the equilibrium is investigated of two masses of liquid each constrainedly spherical, joined by a weightless pipe. Through such a pipe liquid can pass from one mass to the other, and it will continue to do so until, for given radius vector, the masses of the two spheres bear some definite ratio to one another. In other words, two spherical masses of given ratio can be started to revolve about one another in a circular orbit, without relative motion, at such a distance that liquid will not pass through a pipe from one to the other.

The condition for equilibrium is found to be expressible in the form of a cubic equation in the radius vector, with coefficients which are functions of the ratio of the masses. Only one of the three roots of the cubic has a physical meaning, and in all cases the two masses are found to be very close together; but the system can never possess secular stability.

When the masses are no longer constrainedly spherical the equation of condition for equilibrium, when junction is effected by a weightless pipe, becomes very complicated, and can only be expressed approximately. It appears that in all cases, even of Roche's ellipsoids in limiting stability, the masses are much too far apart to admit of junction by a pipe; but when we consider the unstable series of much elongated ellipsoids, it seems that such junction is possible, although the approximation is too imperfect to enable us to draw the figure with any approach to accuracy. If two ellipsoids are unstable when moving detached from one another, junction by a pipe cannot possibly make them stable. This then points to the conclusion that the pear-shaped figure is unstable when so far developed as to be better described as two bulbs joined by a thin neck.

Mr. Jeans has considered the equilibrium and stability of infinite rotating cylinders of liquid.¹ This is the two-dimensional analogue of the three-dimensional problem. He found solutions perfectly analogous to Maclaurin's and Jacobi's ellipsoids and to the pear-shaped figure, and he was able to follow the development of the cylinder of pear-shaped section until the neck joining the two parts had become quite thin. The analysis, besides, points to the rupture of the neck, although the method fails to afford the actual shapes and dimensions in this last stage of development. He is able to prove conclusively that the cylinder of pear-shaped section is stable, and it is important to note that he finds no evidence of any break in the stability up to the division of the cylinder into two parts.

The stability of Maclaurin's and of the shorter Jacobian ellipsoids is well established, and I imagined that I had proved that the pear-shaped figure with incipient furrowing was also stable. But M. Liapounoff² now states that he is able to prove the pear-shaped figure to be unstable from the beginning. For the present at least, I still think it is stable, and this belief receives powerful support from Mr. Jeans's researches.

But there is another difficulty raised by the present paper. I had fully expected to obtain an approximation to a stable figure consisting of two bulbs joined by a thin neck, but although the present work indicates the existence of such a figure, it seems conclusive against its stability. If then Mr. Jeans is right in believing in the stable transition from the cylinder of pear-shaped section to two detached cylinders, and if I am now correct, the two problems must part company at some undetermined stage. M. Liapounoff will no doubt contend that it is at the beginning of the pear-shaped series of figures, but for the present I should dissent from that view.

¹ Phil. Trans., A, vol. cc., pp. 67-104.

² Acad. Imp. des Sci. de St. Pétersbourg, vol. xvii., No. 3, 1905.

One question remains: If the present conclusions are right, do they entirely destroy the applicability of this group of ideas to the explanation of the birth of satellites or of double stars? I think not, for we see how a tendency to fission arises, and it is not impossible that a period of turbulence may naturally supervene in the process of separation. Finally, as Mr. Jeans points out, heterogeneity introduces new and important differences in the conditions.

THE RUSTING OF IRON.

THE first view taken of the atmospheric corrosion or rusting of iron was that it was due to a simple process of oxidation. In 1888 Prof. Crum Brown suggested, on the basis of experiments described by Crace Calvert in 1871, that the first stage in the rusting of iron is the production, under the influence of carbonic acid, of ferrous carbonate, which is subsequently converted, by atmospheric oxygen in presence of moisture, into ferric hydroxide or rust. In 1898, however, Prof. Dunstan, in a lecture delivered to the Royal Artillery Institution, put forward another explanation; he considered that pure oxygen in presence of water is capable of attacking iron, giving rise to ferrous oxide and hydrogen peroxide, part of the latter then converting the ferrous oxide into rust, while the remainder directly attacks the iron, giving rise to a fresh quantity of ferrous oxide, which in turn is again oxidised in a similar manner.

A detailed account of the experiments made in conjunction with Drs. Jowett and Goulding, and of the theory, which may be called the hydrogen peroxide theory of rusting, was published in October of last year in the Transactions of the Chemical Society (vol. lxxxvii., p. 1548). The theory was based on certain phenomena of oxidation in which hydrogen peroxide was known to be formed, and on the consideration that certain substances which decomposed hydrogen peroxide were found to prevent the conversion of iron into rust by damp air. The older theory, that rusting was due to carbonic acid, was considered "quite untenable, since it has been shown that rusting can take place in the absence of carbonic acid"; the part played by carbonic acid was regarded as "subsidiary and not essential," and it was held to be proven that the "aerial oxidation of iron can take place in the absence of carbonic acid." This view was arrived at as the results of experiments in which the authors failed, by attempting to exclude carbon dioxide, to prevent iron from rusting in presence of oxygen and water.

In the April number of the Transactions of the Chemical Society, however, Dr. G. T. Moody shows that these attempts to prevent iron from rusting were unsuccessful owing to the extreme difficulty of completely excluding traces of carbon dioxide. When very special precautions are taken to eliminate this substance iron may be left in contact with pure oxygen and water for many weeks without undergoing change. In one experiment thirty times the quantity of oxygen necessary to convert the whole of the iron into oxide was passed during the course of five weeks, but not even a speck of rust appeared. On the other hand, by removing the scrubbing arrangement by which the air was freed from carbon dioxide, so as to permit the ingress of this gas with the air, rusting commenced almost immediately, and in seventy-two hours the whole of the surface of the metal was seen to be corroded, and a considerable quantity of red rust was formed. Specimens of iron which had been exposed for several weeks to the action of pure oxygen and water without rusting were exhibited by Dr. Moody at the recent conversazione of the Royal Society.

It is also shown by Dr. Moody that while rust is being formed from iron under natural conditions a large proportion of ferrous carbonate is produced; the composition of rust in the course of formation is thus altogether out of harmony with the hydrogen peroxide theory, since this theory postulates that twice as much hydrogen peroxide is produced by the interaction of iron, oxygen, and water as is necessary completely to oxidise the ferrous oxide to the ferric state. The fact that certain compounds such as the

alkalis, sodium nitrite, and potassium ferrocyanide prevent rusting is due, not to their power of decomposing hydrogen peroxide, but of interacting with carbon dioxide. Some substances, such as potassium iodide, which destroy hydrogen peroxide do not inhibit, but actually accelerate, the rusting of iron.

The facts recorded thus afford no basis for the assumption that iron can be caused to rust by pure water and pure oxygen alone, and give a satisfactory explanation of phenomena which were considered as being explicable only in the light of the hydrogen peroxide hypothesis.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Herbert Spencer lecture will be delivered in the examination schools on Thursday, June 7, at 3 p.m., by the Hon. Auberon E. W. M. Herbert, St. John's College.

Dr. G. C. Bourne, fellow of New College, has been nominated to the office of public examiner in zoology for 1906 in succession to the late Prof. Weldon.

At a meeting of the Junior Scientific Club on May 25 some experiments on "liquid crystals" were shown by Messrs. H. B. Hartley (Balliol) and H. L. Bowman (New College).

The following is the text of the speech delivered by Prof. Love in presenting Captain H. G. Lyons for the degree of D.Sc. *honoris causa* on May 29:—

Magnas profecto gratias hodie debemus Aegypto fluvioque Nilo, quo quotannis campos inundante, orta est ex necessitatibus hominum agellos suos summa cura dimittentium, Geometria, subtilissimae cuiusque scientiae parens. Debitum pro portione solvit Magna Britannia, cum moribus institutisque Europaeis in Aegyptum inducendis, tum viris ingenio et scientia pollentibus eo missis, qui ipsis rei publicae rectoribus quasi moderatores et gubernatores sint. In hoc numero locum insignem obtinet Henricus Georgius Lyons, qui cum decem abhinc annos omnia quae ad agrorum dimetiendorum, ad astrorum observandorum rationem pertinent, intermissa invenisset, non solum operam instauravit, sed etiam ipse nova quaedam commentus est, cum de harenae solique aevo et materia, de varia camporum planitie, de imbrium diversitatibus diligentissime quaereret: quod genus cognitionis quam late pateat nemo non videt. Agrorum quidem irrigandorum causa hoc opus noster suscepit, neque praeclarissimos fructus in hac re non assecutus est: nunc agit ut, custodibus et speculatoribus in ripis Nili tanquam in statione dispositis, his nuntiis fretus fluminis incrementum quantum anno proximo futurum sit ante praedicat: qua de re voce non incerta iam loquitur augur optimus. Neque tamen huic viro satis est scientiae et rei publicae inservire: quin vetustissimis illis monumentis quibus abundat Aegyptus magno opere delectatur. Veluti cum Nili regendi causa maximus ille prope Philas agger aedificaretur verebantur homines ne amplificata fluminis vis templis nobilissimis damnum adferret, huius viri laus est fanorum fundamentis confirmatis stabilitisque ita civum commodis consuluisse ut antiquitati venerandae parceretur.

CAMBRIDGE.—The voting on the proposals of the studies and examinations syndicate, which took place last Friday and Saturday, is likely to be misunderstood. The proposals put forward were those suggested by the Bishops of Bristol and Ely and by Mr. S. H. Butcher when the previous recommendations of the syndicate had been rejected. The committee presided over by Dr. Henry Jackson, which exists for the support of the movement in favour of the abolition of compulsory Greek, took no part in the recent agitation; indeed, many of its members voted against the proposals of the syndicate. The committee made no effort to bring up its supporters from the country, and regarded, in fact, the proposals of the syndicate as hardly worth accepting. The studies and examinations syndicate will probably now cease to exist. It has sat for three years and has produced two reports, both of which have been rejected in the main by the clerical vote. It is a well-known fact that in the first contest over compulsory Greek there was a majority of residents in the University

and a majority of laymen in favour of its abolition. It now seems as if nothing but a Royal Commission can remove what to many is an absolute bar to their entrance to the University.

The Hopkins prize of the Cambridge Philosophical Society for the period 1897–1900 has been adjudged to Mr. S. S. Hough, F.R.S., of St. John's College, for his papers on the dynamical theory of the tides, published in the Philosophical Transactions of the Royal Society.

The professor of chemistry gives notice that the chemical laboratory of the University will be open for the use of students in the Long Vacation during July and August. Dr. Fenton will give a course of fifteen lectures on general chemistry on Tuesdays, Thursdays, and Saturdays, beginning on July 5. Mr. J. E. Purvis will give a course of lectures and practical demonstrations in pharmaceutical chemistry for the first part of the third examination for the degree of M.B. on Mondays, Wednesdays, and Fridays, beginning on July 4; and also a revision practical course in the chemistry and physics of hygiene.

The Board of Agricultural Studies announces that an examination will be held for one "Surveyors' Institution scholarship" on July 24–27. The scholarship is tenable for three years, and is of the value of 80*l.* per annum.

PROF. F. FRANZ MARTENS, privat docent for physics in the University of Berlin, who, on Prof. Matthiessens's resignation of the physics chair of the University of Rostock was temporarily appointed as his substitute, has been appointed professor of physics in the Berlin Handels-hochschule.

At the May meeting of the Columbia University trustees, Mr. J. K. Rees, Rutherford professor of astronomy and head of the astronomical department, was made a professor emeritus. Mr. Harold Jacoby succeeds Prof. Rees; Dr. C. Lane Poor will be associated with him as a professor in the department, and Dr. S. A. Mitchell has been promoted to an instructorship in astronomy.

It is reported, says *Science*, that the University of California will lose 12,000*l.* yearly by the destruction of buildings owned by it in San Francisco, and that it will lose a further sum of 10,000*l.* yearly by the reduction in value of assessable property in the State. Our contemporary hopes, however, that the loss of income on the San Francisco property is only temporary, and that the State will not permit the University to suffer from the decrease in the taxes.

THE Society for the Advancement of Mathematical Scientific Instruction will hold an annual general meeting in Erlangen during next week. Among the papers of general interest will be:—the investigations of glaciers, by Prof. Hess, of Ausbach; the experiment in ancient times and in the Middle Ages, by Prof. Wiedemann, of Erlangen; the proposals of the education commission of the Naturforschergesellschaft (p. 92), by Prof. Pietzker, of Nordheim; and the conception of number and quantity in teaching, by Prof. Wieleitner, of Speyer. Excursions will be made to Nürnberg and the French Switzerland.

AN agreement for the mutual recognition of certificates has been arrived at between the Universities of Manchester, Liverpool, Leeds, and Sheffield Joint Matriculation Board and the Universities of Oxford and Cambridge. This Joint Matriculation Board will grant exemption from its matriculation examination to persons who have passed Responsions at Oxford with one additional subject, or have passed parts i. and ii. of the Previous Examination at Cambridge with one of the additional subjects. Under certain conditions as to the subjects taken, exemption will also be granted to holders of higher certificates of the Oxford and Cambridge Senior Local examinations. It will be remembered that a similar arrangement between the Universities of Oxford, Cambridge, and London has been announced already. Holders of Oxford and Cambridge Local certificates or higher certificates of the Oxford and Cambridge Joint Board are, if they have taken certain subjects, given exemption from the London Matriculation. Similarly, the Matriculation examination, in certain circumstances, gives exemption from Oxford Responsions and the Cambridge Previous examination.